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(54) Shaped foamable materials

(57) Shaped foamable structures 10 for filling hollow structural members 1 are described and preferably include a shaped foamable material 11 constructed from a plurality of foamable pieces 12 that are arranged with desired clearances and are interconnected with each other, and an attaching means 30 for positioning the shaped foamable material 11 within a cavity 6 of the hollow structural member 1. Methods of placing the shaped foamable structures 10 within the hollow structural members 1 and heating the foamable material 11 to expand and fill the hollow structural member 1 are also described.

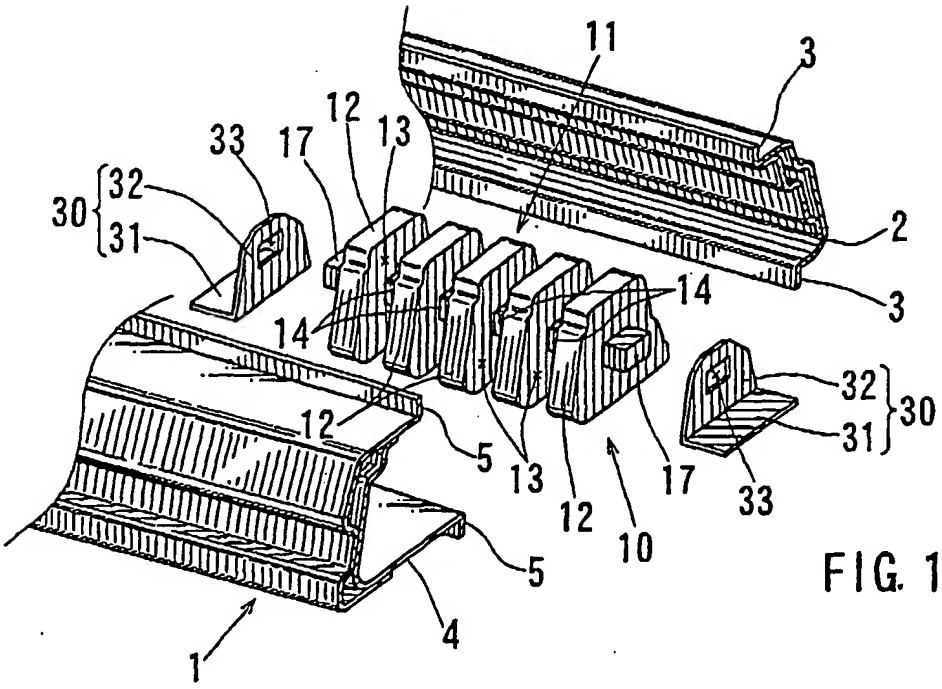

FIG. 1

EP 1 006 022 A2

Description

[0001] The present invention relates to shaped foamable structures that can be used, for example, to fill a cavity of a hollow structural member and to reinforce the hollow structural member. The present invention also relates to shaped foamable materials and attaching devices that can be used to support the shaped foamable materials in a closed box-like hollow structural member constructed from a plurality of plates, such as rocker panels, pillars and roof side panels of a vehicle body. After being expanded, the foam material increases the damping and sound insulating powers of the hollow structural member and increases the strength and rigidity of the hollow structural member.

[0002] Japanese Patent Laid-open Application Number 8-208871, and its corresponding US Patent No. 5,631,304, describe a foamable material for filling and reinforcing a hollow structure. In particular, a foamable material having block-like structure is taught and the block-like structure preferably has the same profile as the interior of the hollow structure. The block-like structure is placed against the interior of the hollow structure and heated in order to expand or foam the material, thereby filling and reinforcing the hollow structure.

[0003] It is an object of the present teachings to provide improved filling and reinforcing shaped foamable materials for hollow structures. Preferably, by modifying the exterior shape of the shaped foamable material, the time required to completely foam the shaped foamable material can be significantly reduced. In addition, it may be possible to improve the expansion properties of the shaped foamable materials.

[0004] In one aspect of the present teachings, a shaped foamable material is formed from a plurality of foamable pieces. Preferably, the foamable pieces have clearances between each foamable piece, but are interconnected to each other for convenience of use. One or more support members or attaching means may be provided to position the interconnected foamable pieces within the cavity of the hollow structural member. Preferably, the interconnected foamable pieces do not contact the interior surface of the hollow structure. Instead, only the support members or attaching means contact the interior surface of the hollow structure. Therefore, the interior surface of the hollow structure can be painted after the foamable pieces are mounted inside the hollow structure, and before expanding the foamable pieces, because the foamable pieces do not block or cover the interior surface of the hollow structure.

[0005] With such interconnected foamable pieces, external heating for expanding the shaped foamable material can be effectively conducted throughout the entire shaped foamable material. That is, the clearances provided between the foamable pieces allow the entire shaped foamable material to be quickly and uniformly heated, thereby ensuring that the foam pieces expand at the desired ratio in a short amount of time.

[0006] Such a shaped foamable material is particularly advantageous for a hollow structure having a relatively large cross-sectional area, because the shaped foamable material should have a corresponding large cross-sectional area, so as to sufficiently fill the hollow structure cavity after expansion. The clearances provided within the present shaped foamable materials considerably reduce the time that it takes to completely foam or expand the shaped foamable material compared to foamable materials having a block shape. For example, if a block like foamable material is utilized for a hollow structure having a particularly large cross section, the center portion of the block like foamable material may not sufficiently foam or expand. Such problems can be overcome by the present shaped foamable materials.

[0007] In one aspect, the interconnected foamable pieces of the shaped foamable material can be integrally formed by injection molding. This alternative provides an easy to use shaped foamable material, if the cavities of the hollow structures have uniform lengths. In the alternative, the interconnected foamable pieces can be separately formed. After forming the individual pieces, the foamable pieces can be interconnected by a variety of means for connecting the foamable pieces. Therefore, the length of the shaped foamable material can be easily changed, if necessary.

[0008] The invention will be further described by way of example with reference to the accompanying drawings, in which:

FIG. 1 is an exploded perspective view of a shaped foamable material for a rocker panel according to a first representative embodiment of the present teachings;

FIG. 2 is a vertical sectional view of the shaped foamable material disposed in a cavity of the rocker panel before the shaped foamable material is expanded;

FIG. 3 is a sectional view taken along the line III-III in FIG. 2;

FIG. 4 is a vertical sectional view of the shaped foamable material disposed in the cavity of the rocker panel after the shaped foamable material is expanded;

FIG. 5 is a sectional view taken along the line V-V in FIG. 4;

FIG. 6 is a schematic view of a vehicle body showing the position of the rocker panel;

FIG. 7 is a perspective view of a shaped foamable material of a shaped foamable material for a rocker panel according to a second representative embodiment of the present teachings;

FIG. 8 is a vertical sectional view of the shaped foamable material disposed in a cavity of the rocker panel before the shaped foamable material is expanded; and

FIG. 9 is a perspective view of a modified form of the shaped foamable material according to the sec-

ond representative embodiment.

[0009] In the course of further researching the foamable materials described in US Patent No. 5,631,304, it was discovered that the expansion or foaming properties of the foamable materials could be remarkably improved by modify the shape of the foamable materials. In particular, it was found that a fin like foamable structure can be quickly expanded using external heat. This fin like structure will expand into a uniform foamed structure that provides excellent sound proofing and reinforcing properties. Other types of structures that improve the uniform heating and foaming capabilities of the foamable materials are naturally contemplated by the present teachings.

[0010] In addition, the block shaped foamable material of US Patent No. 5,631,304 is mounted onto the surface of the hollow structure before expansion. However, if the hollow structure has not been painted before the block shaped foamable material is placed inside the hollow structure, the portions of the hollow structure interior can not be painted to protect the hollow structure interior from corrosion. That is, if the foamable material is mounted directly onto the interior surface of the hollow structure, the foamable material may block the paint from reaching the portions of the interior surface of the hollow structure.

[0011] Therefore, in order to provide an improved shaped foamable structure, one or more mounting devices may preferably be used to provide a clearance between the foamable structure and the interior surface of the hollow structure. Thus, the hollow structure can be assembled with the foamable material mounted inside the hollow structure using at least one mounting device, such that the foamable material does not cover or block any interior surfaces of the hollow structure. After painting the interior of the hollow structure, for example by dip painting, the foamable material can be heated to expand and fill the hollow structure. In this case, the interior surface of the hollow structure has been painted to prevent corrosion.

[0012] As a result, the foamable materials are preferably shaped for hollow structural members, such that the shaped foamable material is formed from a plurality of foamable pieces that are arranged with desired clearances and are interconnected with each other. Preferably, an attaching means is utilized to position the shaped foamable material in a cavity of the hollow structural member. The shaped foamable material may preferably be disposed within the cavity of the hollow structural member in such a way that the foamable pieces of the shaped foamable material are arranged along the longitudinal direction of the hollow structural member. Most preferably, the shaped foamable material has a shape appropriate for a rocker panel of a vehicle body.

[0013] The foamable pieces of the shaped foamable material may be integrally formed by injection molding. In the alternative, the respective foamable pieces of the shaped foamable material may be separately formed and then interconnected to provide an easy to use shaped foamable material. For example, the foamable pieces may be interconnected with a connecting means, which for example may be a tenon and a corresponding mortice provided on the opposite surfaces of each of the foamable pieces, respectively. The tenon and mortise may have any of a variety of corresponding shapes.

[0014] In addition, methods of using foamable materials are taught. For example, the shaped foamable structure may be disposed inside of a hollow structure and the shaped foamable structure and the hollow structure may be heated, thereby expanding the shaped foamable structure. Preferably, a cross-linked, rigid foam structure is formed within the hollow structure, thereby providing sound dampening properties and reinforcing the hollow structure. Various compositions may be utilized to form the shaped foamable structure. Further, means for expanding the shaped foamable structure, other than heating, may be utilized. Additionally, one or more support pieces may be utilized to fix the shaped foamable structure inside the hollow structure, so that the shaped foamable structure does not contact the interior of the hollow structure. Moreover, the hollow structure may optionally be dipped in a paint bath after the shaped foamable structure has been placed inside the hollow structure, but before the shaped foamable material is expanded.

[0015] For the purposes of this specification, the term "foamable" is used to describe materials that can be expanded in size by means of an external energy source, such as heat. Thus, a "foamable" material is capable of expanding to form a foam like structure. The expansion ratio typically can be adjusted by adjusting the various compositions utilized to form the foamable material.

[0016] Each of the additional features and constructions disclosed above and below may be utilized separately or in conjunction with other features and constructions to provide improved shaped foamable materials and methods for making and using such shaped foamable materials. Detailed representative examples of the present invention, which examples utilize many of these additional features and constructions in conjunction, will now be described in detail with reference to the drawings. This detailed description is merely intended to teach a person of skill in the art further details for practicing preferred aspects of the present teachings and is not intended to limit the scope of the invention. Only the claims define the scope of the claimed invention. Therefore, combinations of features and steps disclosed in the following detail description may not be necessary to practice the invention in the broadest sense, and are instead taught merely to particularly describe some representative examples of the invention, which detailed description will now be given with reference to the accompanying drawings.

[0017] A first representative embodiment of the invention is shown in FIGS. 1 to 6. As shown in FIG. 6, a rocker

panel 1 of a vehicle body A will be used as an example of a representative hollow structural member. As best shown in FIGS. 1 and 3, the rocker panel 1 is constructed from an elongated inner panel 2 having flanges 3 extending along the peripheral edges of the elongated inner panel 2, and an elongated outer panel 4 having flanges 5 extending along the peripheral edges of the elongated inner panel 2. As will be readily appreciated, each of the inner panel 2 and the outer panel 4 is a two-piece construction having a pair of panel pieces. Such two-piece panels are used in order to increase the strength of the rocker panel. However, each of the panels 2 and 4 can be of a one-piece construction, if desired. The inner panel 2 and the outer panel 4 preferably are welded at flanges 3 and 5 by spot welding, so that the rocker panel 1 has an elongated, enclosed hollow structure and has a longitudinally extending cavity 6 inside the hollow structure.

[0018] As best shown in FIGS. 1 to 3, a shaped foamable structure 10 is preferably fixed within the cavity 6 of the rocker panel 1. This shaped foamable material 11 can be expanded to fill the cavity 6 and reinforce the rocker panel 1. The shaped foamable structure 10 is preferably constructed from a shaped foamable material 11 that is in an unfoamed state, and an attaching means or a pair of support members 30 for positioning the shaped foamable material 11 in the cavity 6. Each of the support members 30 can be a folded plate-like member that is formed of a steel plate and has a fixture base 31 and a support wall 32 that cross at right angles. Other designs for the support member naturally may be utilized.

[0019] The support members 30 are preferably disposed in the cavity 6 of the rocker panel 1 at desired intervals in such a way that the support walls 32 are facing each other and are substantially perpendicular to the longitudinal direction of the cavity 6. The fixture bases 31 of the support member 30 can be secured to an inner surface of the rocker panel 1 by spot welding or other such fixing methods, so that the support members 30 are attached to the cavity 6. As best shown in FIG. 1, the support wall 32 of each support member 30 preferably has a non-circular opening 33 that is formed at the center of each support wall 32. The opening 33 may have a variety of shapes, although it preferably has a rectangular shape in this embodiment.

[0020] As will be readily appreciated, the fixture bases 31 may be secured to the bottom surface of the outer panel 4 before the inner panel 2 and outer panel 4 are welded at flanges 3 and 5 in order to form the rocker panel 1. In other words, the inner panel 2 and the outer panel 4 provided with the support members 30 are joined to each other, thereby forming the hollow rocker panel 1 that receives the support members 30 in the cavity 6 of the hollow rocker panel 1.

[0021] As best shown in FIG. 3, the support wall 32 of each support member 30 has an external dimension sufficiently smaller than the dimension of the transverse cross section of the cavity 6, so as to form a clearance between the periphery of the support member 30 and the inner surface of the rocker panel 1. This clearance is intended to permit paint to flow within the cavity 6 of the rocker panel 1 along the inner surface of the rocker panel 1, when the vehicle body A is dipped into a paint bath. As will be recognized, the paint can be introduced into the cavity 6 through paint introduction holes (not shown) that may be formed in the rocker panel 1.

[0022] In this representative embodiment, although the pair of support members 30 are secured to the inner surface of the rocker panel 1 by spot welding, the support members 30 can be secured together using other securing means, such as screws, clips, magnets and adhesives, etc. In addition, the support members 30 can be made from heat-resistant synthetic resins or other such materials instead of a metal, such as steel.

[0023] Further, as shown in FIGS. 1 and 2, the shaped foamable material 11 can be a one piece element and can be supported by the pair of support members 30. The shaped foamable material 11 may preferably be constructed from a series of plate-like foamable pieces 12 that are arranged in parallel with desired clearances 13, a plurality of connecting pieces 14 that integrally interconnect the foamable pieces 12 at their central parts, and a pair of engagement projections 17 that are integrally provided on the foamable pieces 12 that are positioned at both ends of the series, respectively. As best shown in FIG. 2, these engagement projections 17 may project outward in an opposite relation and can engage the openings 33 of the support members 30. Each engagement projection 17 may preferably be adapted to tightly fit into the opening 33 that is formed in the support wall 32 of each support member 30. That is, the engagement projection 17 may, for example, have a rectangular cross section that corresponds to the rectangular cross section of the opening 33. Therefore, the support members 30 can non-rotatably fix the shaped foamable material 11 when each engagement projection 17 is inserted into the opening 33 of the support member 30.

[0024] Moreover, as best shown in FIG. 3, each of the foamable pieces 12 in the unfoamed state preferably has an outer dimension that substantially conforms to the transverse cross-sectional configuration of the cavity 6. Further, the external dimension may be slightly smaller than the dimension of the transverse cross section of the cavity 6, so that a clearance exists between the periphery of the foamable pieces 12 and the inner surface of the rocker panel 1. This clearance is intended to permit paint to flow in the cavity 6 of the rocker panel 1 along the inner surface of the rocker panel 1, when the vehicle body A is dipped into the paint bath.

[0025] While various compositions can be utilized to form the shaped foamable material 11 (i.c., the foamable pieces 12, the connecting pieces 14 and the engagement projections 17), it is preferably made of a foamable material, such as foaming agents containing synthetic resinous materials, that can foam or expand at temper-

atures from about 110° C to about 190° C to provide a foamed product 20 (FIGS. 4 and 5). In addition, the foamable material preferably contains metal adhesive resins, fibrous materials and other additives, so as to produce a foamed product 20 that has high rigidity when it is expanded within the above-noted temperature range. By way of example, the foaming agents may be azodicarbonamide (ADCA), oxy-bis(benzenecarbonyl hydrazide), dinitrosopentamethylenetetramine or other similar compounds. The metal adhesive resins may be an ethylene-methyl acrylate copolymer resin (EMA), an ethylene-ethyl acrylate copolymer (EEA), an etylene-butyl acrylate copolymer (EBA) or other similar compounds. The fibrous materials may be glass fibers, organic fibers or other fibers. Further, the foamable material preferably is formulated so as to expand at an expansion ratio of about 2 to 5. Further examples of representative foamable material that can be used with the present teachings are disclosed in US Patent No. 5,631,304 and US Patent Application No. 09/322,779, filed May 28, 1999, which patent references are hereby incorporated by reference in their entirety.

[0026] A representative method for incorporating the shaped foamable structure 10 into the cavity 6 of the rocker panel 1 and subsequent operations will now be described. Specifically, the fixture base 31 of one of the support members 30 may be first secured to the bottom surface of the outer panel 4 by spot welding or other such methods in such a way that the support wall 32 is substantially perpendicular to the longitudinal direction of the outer panel 4. The inner panel 2 and outer panel 4 may then be welded at flanges 3 and 5 in order to form the rocker panel 1. Subsequently, one of the engagement projections 17 of the shaped foamable material 11 may be inserted into the opening 33 of the support wall 32 of the secured support member 30. Support member 30 may be positioned on the bottom surface of the outer panel 4 in such a way that its support wall 32 faces the support wall 32 that was previously secured to the outer panel 4. At the same time, the second engagement projection 17 of the shaped foamable material 11 may be inserted into the opening 33 of the support wall 32 of this support member 30. Under this condition, the fixture base 31 of the second support member 30 can be secured to the bottom area of the outer panel 4 by spot welding or other such methods. Thus, the shaped foamable structure 10 is attached to the outer panel 4 in a manner that the foamable pieces 12 of the shaped foamable material 11 are preferably arranged in series along the longitudinal direction of the outer panel 4.

[0027] Subsequently, the inner rocker panel 2 and the outer rocker panel 4 are welded at flanges 3 and 5 thereof by spot welding to form the rocker panel 1 having the shaped foamable structure 11 disposed in the cavity 6. As a result, the shaped foamable structure 10 is attached in the cavity 6 of the rocker panel 1 in such a way that the shaped foamable material 11 extends along the longitudinal direction of the cavity 6. As shown in FIGS. 2 and 3, the shaped foamable material 11 is preferably retained within the cavity 6 without contacting the inner surfaces of the panels 2 and 4, so as to form a clearance between the periphery of the shaped foamable material 11 and the inner surface of the rocker panel 1.

[0028] Thereafter, the entire rocker panel 1 may optionally be introduced into the paint bath. During this dip painting operation, the paint coats the outer surface of the rocker panel 1. The paint also enters the cavity 6 through paint introduction holes (not shown) that may be formed in the rocker panel 1. Thus, the paint also coats the cavity surfaces of the rocker panel 1. As will be easily understood, the paint introduced into the cavity 6 will be effectively applied to the inner surfaces of the rocker panel 1, because the shaped foamable material 11 is retained without contacting the inner surfaces of the rocker panel 1. As a result, the paint may suitably coat the cavity surfaces of the rocker panel 1 without leaving any un-painted portions.

[0029] The rocker panel 1 can be heated using any suitable external heating source to both bake the paint coat and heat the shaped foamable material 11 within the cavity 6. As a result, the heated shaped foamable material 11 (i.e., the foamable pieces 12, the connecting pieces 14 and the engagement projections 17) will expand to produce the foamed product 20, as shown in FIGS. 4 and 5. The foamed products 20 thus produced reliably adhere to the entire interior surface of the rocker panel cavity 6. As a result, the foamed product 20 fills or closes the cavity 6, thereby providing excellent damping and sound insulation powers, as well as rigidity, to the rocker panel 1.

[0030] It is important to note that when the shaped foamable material 11 is heated by the external heat source, the heat can be effectively conducted to the shaped foamable material 11, due to the clearances 13 provided between the foamable pieces 12. As a result, the shaped foamable material 11 can be quickly and uniformly heated, so as to foam at a desired expansion ratio in a short amount of time. Therefore, such a shaped foamable structure 10 may be specifically useful, if the rocker panel 1 has a large cross-sectional area.

[0031] Also, as best shown in FIG. 4, when the shaped foamable material 11 is expanded by heating, the support walls 32 of the support members 30 may effectively prevent the foamed product 20 from inappropriately expanding in the longitudinal direction of the cavity 6, because the shaped foamable material 11 is retained between the support members 30 that are arranged perpendicular to the longitudinal direction of the cavity 6. Therefore, the foamed product 20 desirably fills or closes the cavity 6 of the rocker panel 1 and reliably adheres to the entire cavity surface. This feature may further contribute to increasing damping and sound insulation powers and rigidity of the rocker panel 1.

[0032] In this embodiment, each of the foamable pieces 12, the connecting pieces 14 and the engagement projections 17 can be formed by injection molding the

foamable material. However, the present invention is naturally not limited to this type of structure. For example, the connecting pieces 14 and the engagement projections 17 can be made of an unfoamable synthetic resin rod or a metal rod (not shown), if desired. As will be appreciated, in such a case, the foamable pieces 12 are formed on the rod preferably by injection molding, so as to produce the shaped foamable material 11 that is externally constructed from the foamable pieces 12, the unfoamable connecting pieces 14, and the unfoamable engagement projections 17.

[0033] A second representative embodiment, which is closely related to the first representative embodiment, is shown in FIGS. 7 and 8. Therefore, only constructions that are different from those constructions described in the first representative embodiment will be explained with respect to the second representative embodiment.

[0034] As shown in FIGS. 7 and 8, the shaped foamable material 11 is substantially constructed from a plurality of foamable pieces 12 and one specially formed foamable piece 12a, which pieces are formed separately from each other. Preferably, each of the foamable pieces 12 has a tenon 15 to serve as a connecting means, which tenon 15 is provided on at least one surface of each foamable piece 12. The tenon 15 preferably has a rectangular cross section and a desired length. Moreover, each foamable piece 12 has a corresponding mortise 16 to serve as the connecting means, which mortise 16 is formed on the opposite surface from the tenon 15. The tenon 15 and mortise 16 are preferably formed to fit tightly together and the depth of the mortise 16 is preferably less than the length of the tenon 15.

[0035] On the other hand, unlike the normal piece 12, the special foamable piece 12a has tenons 15 provided on both surfaces. These tenons 15 preferably project in opposite directions and are aligned with each other.

[0036] The normal foamable pieces 12 and the special foamable piece 12a may be arranged in series in such a way that the tenons 15 and the mortises 16 are adjacent to each other. Thereafter, the respective tenons 15 are press fitted into the respective mortises 16, thereby producing the shaped foamable material 11 in which the foamable pieces 12 and 12a are arranged in parallel with desired clearances 13.

[0037] As will be easily recognized, in the shaped foamable material 11 thus constructed, the tenon 15 of the terminal normal foamable piece 12 and the remaining tenon 15 of the special foamable piece 12a function as engagement projections that engage the openings 33 that is formed in the support wall 32 of each support member 30. Therefore, each tenon 15 is preferably formed to fit tightly inside each opening 33.

[0038] In this embodiment, the tenon 15 has a rectangular cross section and the mortise 16 has a corresponding rectangular shape so as to tightly fit with the tenon 15. However, the shapes of the tenon 15 and the mortice 16 are not limited to such a shape. For example, as shown in FIG. 9, the tenon 15 can be provided with a removed part 15a along the entire length thereof, and the mortice 15 can be provided with a corresponding removed part 16a extending therethrough. In other words, the tenon 15 and the mortise 16 can be designed so as to have a notched rectangular cross section. As will be easily understood, in such a structure, the adjacent foamable pieces 12 and 12a can be necessarily aligned in desired directions. As a result, the foamable pieces 12 and 12a can not be inadvertently coupled in the wrong position. Therefore, the shaped foamable material 11 can be easily and reliably manufactured.

[0039] Further, it is important to note that the shapes of the tenon 15 and the mortise 16 are also not limited to the notched rectangular cross section. Instead, the cross-sectional shape of the tenon 15 and the mortise 16 can be, for example, a trapezoidal shape, a triangular shape, a notched circular shape or other such shapes that can provide such a connecting function.

[0040] Moreover, in the first and the second representative embodiments, the shaped foamable material 11 is positioned and supported in the cavity 6 of the rocker panel 1 by means of the pair of support members 30. However, the attaching means is not limited to such support members 30.

[0041] Further, the rocker panel 1 of a vehicle body has been utilized as a representative hollow structural member. However, the hollow structural member is not limited to the rocker panel and may be a pillar, a roof side panel or other panels of a vehicle body. Moreover, the hollow structural member is not limited to parts of a vehicle body, as the present teachings are equally applicable to the filling and/or reinforcing of any hollow members, such as structural components for buildings and ships.

Claims

1. A shaped foamable structure for use in a hollow structural member, comprising:

   a shaped foamable material comprising a plurality of interconnected foamable pieces having clearances to facilitate uniform heating of the shaped foamable material.

2. A shaped foamable structure according to claim 1, further comprising at least one support member attached to the shaped foamable material for positioning the shaped foamable material within a cavity of a hollow structural member.

3. A shaped foamable structure as in claim 1 or 2, wherein the shaped foamable material has a fin-like structure.

4. A shaped foamable structure as defined in claim 2 or 3, wherein the foamable pieces are integrally formed.

5. A shaped foamable structure as defined in claim 1, 2, 3 or 4, wherein each respective foamable piece is separately formed and the respective foamable pieces are interconnected by connecting means formed on the foamable pieces.

6. A shaped foamable structure as defined in claim 5, wherein the connecting means comprises a tenon and a corresponding mortice provided on the opposite surfaces of each of the respective foamable pieces.

7. In combination:

a shaped foamable structure as in claim 1, 2, 3 or 6 and
a hollow structure, wherein the shaped foamable structure is fixed within the hollow structure such that the exterior surface of the shaped foamable material does not contact the interior surface of the hollow structure and the shaped foamable material can be disposed in the interior of the hollow structural member such that the foamable pieces of the shaped foamable material are arranged along the longitudinal direction of the hollow structural member.

8. A method forming a foam structure within a hollow structure comprising the steps of:

fixing a shaped foamable material inside the hollow structure such that the exterior of the shaped foamable material does not contact the interior of the hollow structure, wherein the shaped foamable material comprises clearances formed within the shaped foamable material that facilitate heating of the shaped foamable material and
heating the shaped foamable material and the hollow structure, whereby the shaped foamable material expands to fill and adhere to the interior surface of the hollow structure.

9. A method as in claim 8, further comprising dipping the hollow structure and shaped foamable material in a paint bath before the heating step, so as to coat the entire interior surface of the hollow structure with paint.

10. A method as claimed in claim 8 or 9, wherein the shaped foamable material comprises a shaped foamable structure in accordance with any one of claims 1 to 6.

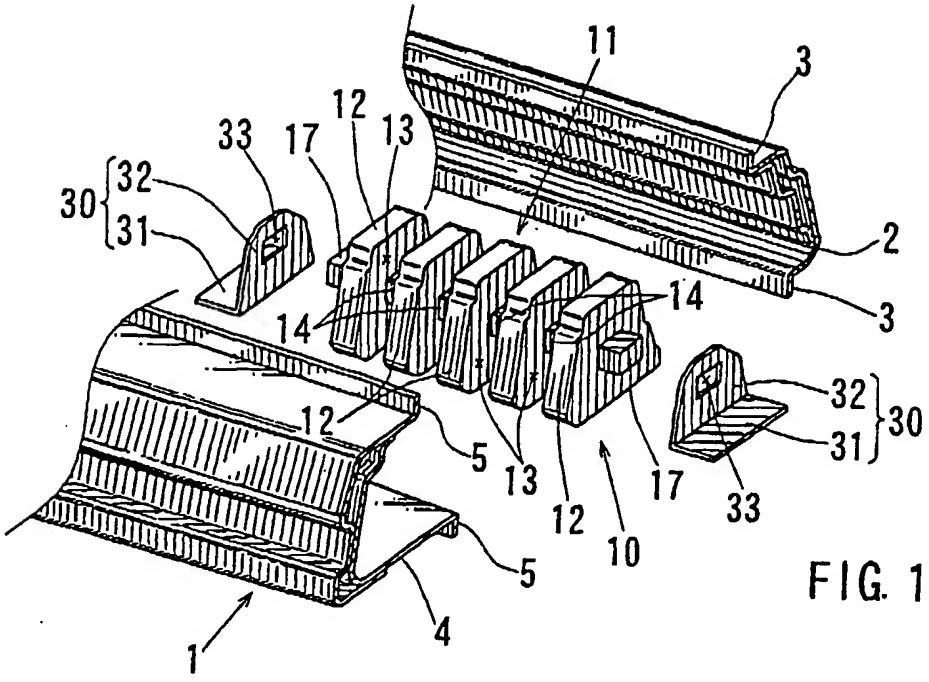

FIG. 1

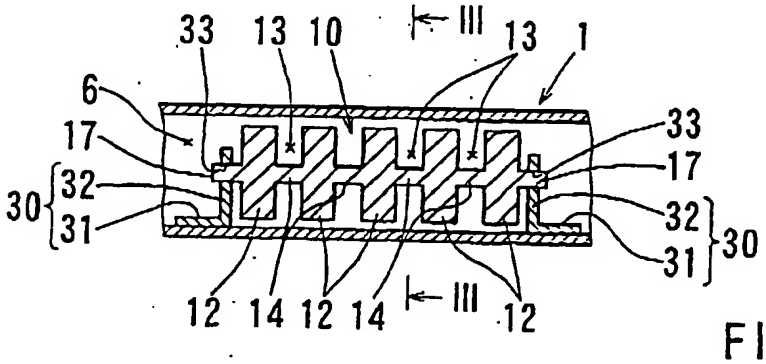

FIG. 2

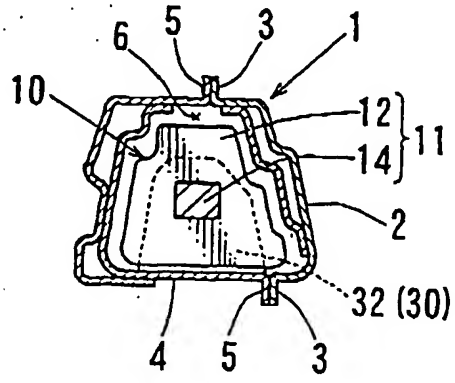

FIG. 3

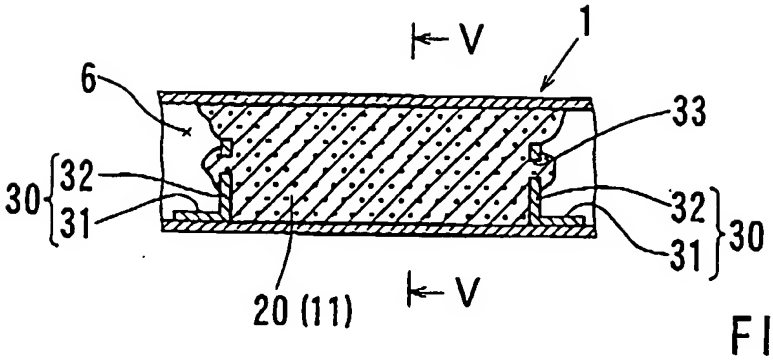

FIG. 4

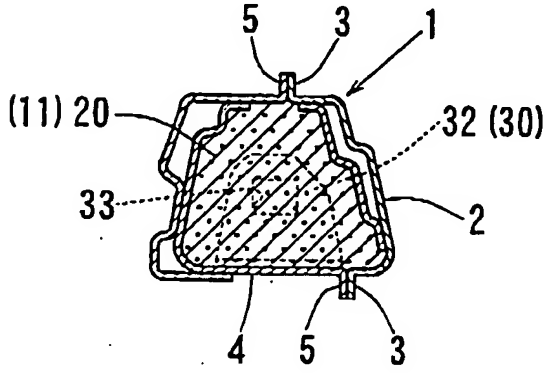

FIG. 5

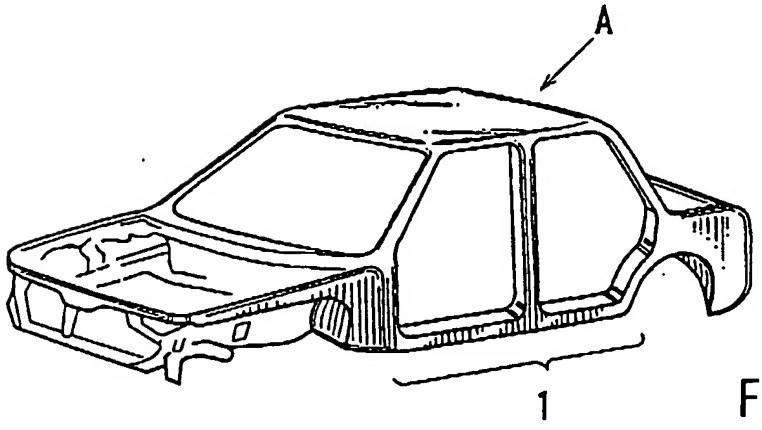

FIG. 6

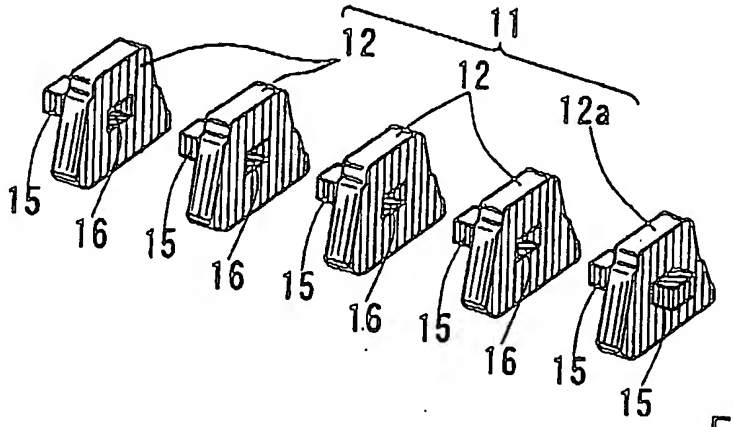

FIG. 7

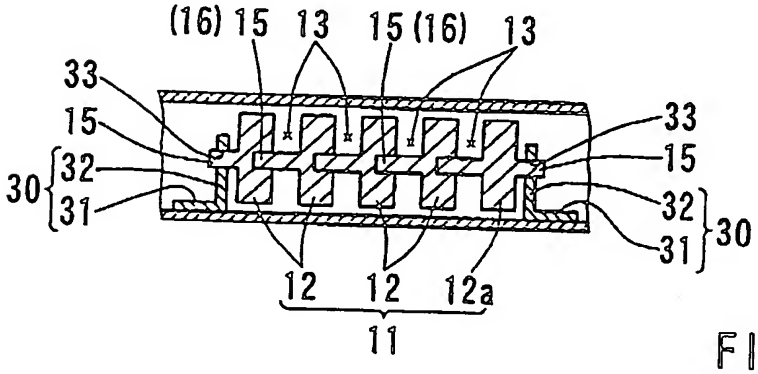

FIG. 8

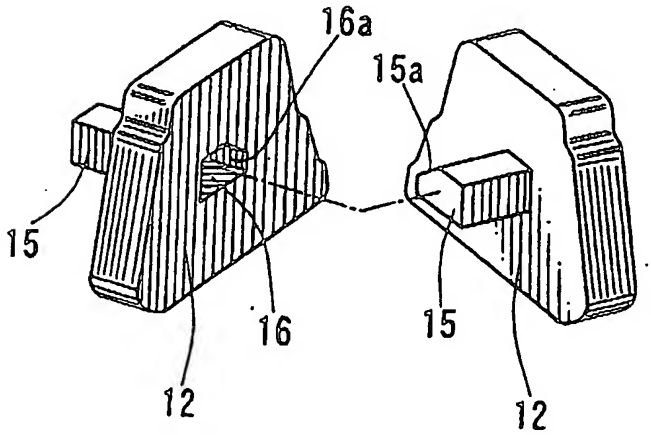

FIG. 9

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(54) Shaped foamable materials

(57) Shaped foamable structures 10 for filling hollow structural members 1 are described and preferably include a shaped foamable material 11 constructed from a plurality of foamable pieces 12 that are arranged with desired clearances and are interconnected with each other, and an attaching means 30 for positioning the shaped foamable material 11 within a cavity 6 of the hollow structural member 1. Methods of placing the shaped foamable structures 10 within the hollow structural members 1 and heating the foamable material 11 to expand and fill the hollow structural member 1 are also described.

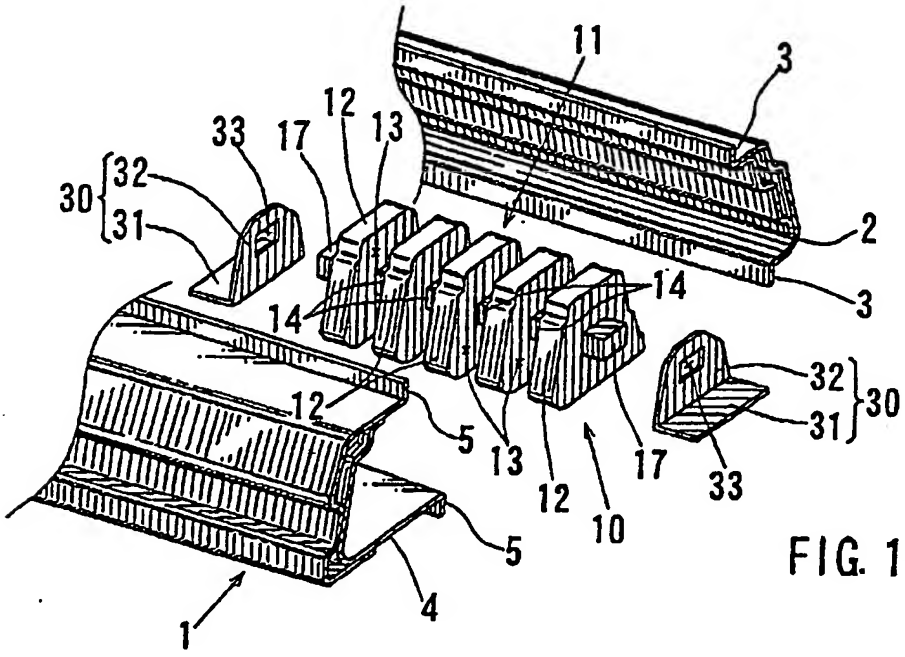

FIG. 1

EP 1 006 022 A3

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EUROPEAN SEARCH REPORT

Application Number
EP 99 30 9489

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

B60R
B62D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	30 June 2000	Kusardy, R

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